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White Fir

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The term "white fir" as commonly used in the lumber trade and in this leaflet includes several species of true firs[1] that grow in the western part of the United States and produce wood quite similar in

Figure 1.—Range of white fir (*Abies concolor*).

[1] The term "true fir" is used for the species of the genus *Abies* to distinguish them from Douglas-fir (*Pseudotsuga taxifolia*), not a closely related species. There are 10 species of true firs native to the United States. Eight of these grow in the West and 2 in the East. The 8 western true firs are white fir (*Abies concolor*), grand fir (*A. grandis*), red fir (*A. magnifica*), Pacific silver fir (*A. umabilis*), noble fir (*A. procera*), alpine fir (*A. lasiocarpa*), corkbark fir (*A. lasiocarpa* var.), and bristlecone fir (*A. venusta*). The 2 species of eastern true firs are balsam fir (*A. balsamea*) and Fraser fir (*A. fraseri*).

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appearance and properties. Two species make up the greater part of "white fir" lumber—white fir (*Abies concolor*) and grand fir (*A. grandis*). Other western true firs, one or more of which may make up some part of "white fir" shipments, are: Pacific silver fir, California red fir, noble fir, and alpine fir.

"White fir" lumber is generally white, soft, light in weight, free from pitch, low in strength properties and decay resistance, and more difficult to season than that of the western pines or Douglas-fir, with which it generally grows and is sometimes logged, milled, and marketed. Its principal uses are for construction purposes in small buildings and for paper pulp. The market for "white fir" lumber is limited by prejudice against the wood, due in part at least to the sale of improperly seasoned material and in part to the established reputation of competing woods. This condition tends to concentrate the cutting on the more desirable species and to leave in the forest an increasing percentage of the true firs—an unsatisfactory situation from the forest management standpoint.

The combined stand of white fir and grand fir is considerably greater than the stand of sugar pine or western white pine and much smaller than the stands of Douglas-fir or ponderosa pine.

Nomenclature.—Following are the names of the six species of western true firs, several of which, in widely varying proportions, may be included in shipments of "white fir" lumber.

Common name	Botanical name	Other names
White fir	*Abies concolor*	Balsam fir. Silver fir. White balsam.
Grand fir	*Abies grandis*	White fir. Balsam fir. Lowland fir. Silver fir. Yellow fir.
Pacific silver fir	*Abies amabilis*	Silver fir. Red fir. White fir. Larch. Lovely fir.
California red fir	*Abies magnifica*	Golden fir. Red fir. California red bark fir. White fir.
Noble fir	*Abies procera*	White fr. Red fir. Larch.
Alpine fir	*Abies lasiocarpa*	Balsam. White balsam. White fir.

Distribution and growth.—White fir (*A. concolor*) grows principally along the coast and interior mountain ranges of California and southern Oregon and also in scattered stands in the mountains throughout the Southwest (fig. 1). It grows at moderate altitudes in the northern part of its range and at increasingly higher altitudes southward. White fir reaches its best development in northern California. Here trees 50 years old reach an average height of 50 feet and average diameter of 8 inches. Mature timber in California averages about 100 feet in height and 2 feet in diameter. Occasional trees reach 200 feet and a diameter of 6 feet at approximately 300 years.

In the central and southern Rocky Mountains mature trees average 70 feet in height and 18 inches in diameter.

White fir grows rapidly when young but is comparatively short-lived. In the Rocky Mountains trees over 125 years old are frequently defective. The species never forms pure stands, generally growing in mixture with ponderosa pine or Douglas-fir. It is a prolific seeder, and the seeds germinate and grow under a wide variety of conditions of soil, climate, and exposure. The tree is tolerant of

FIGURE 2.—Range of grand fir (*Abies grandis*).

shade throughout its life and especially when young. This ability to withstand shade results in many branches on the trunks and a high proportion of knotty lumber. The thick bark of the older trees offers considerable resistance to fire. In young trees, however, the bark, twigs, and branches are resinous and inflammable.

Grand fir grows principally in western Oregon, northern Idaho, along the coast of northern California, and in western and northern Washington (fig. 2). It also grows along the coast in southwestern British Columbia and in southern British Columbia along the

border between the United States and Canada. It prefers moist situations, making its best growth on the lower slopes of mountains, in depressions and gulches. At higher elevations the trees are much smaller.

Under favorable conditions grand fir attains a diameter of 4 feet and height of 200 feet. On less favorable sites at higher elevations mature trees average 18 inches in diameter and 80 feet in height. The larger trees throughout its range are frequently defective. Grand fir is rarely found in pure stands except on small areas and generally grows in mixture with western white pine, western red-cedar, western hemlock, and Douglas-fir. It produces a moderate amount of seed which germinate readily in a variety of soils, provided sufficient moisture is present. The trunks are generally straight and when in close stands are clear of branches for one-third or more of their length. In an open forest, however, the branches extend nearly to the ground.

The range of Pacific silver fir extends from the southern extremity of Alaska southward along the British Columbia coast through the State of Washington to southern Oregon. (See fig. 3 for range in the United States.) It is commonly found in mixture with other species but also occurs in pure stands of limited size. In the Olympic Mountains of Washington, where the most favorable growth conditions for Pacific silver fir are found, individual trees may reach a height of 200 feet and diameter of 3 to 5 feet, but these are exceptional even under the best conditions. Under average conditions mature trees are generally 75 to 100 feet in height and 18 to 30 inches in diameter.

Pacific silver fir grows at elevations ranging from near sea level to 6,000 feet or more. In dense forests the trunks are often free of branches for at least 50 feet from the ground, but, where the stand is open, they are generally thickly covered with short branches. Pacific silver fir grows slowly, and trees 2 feet in diameter are frequently over 200 years old. Seed is produced in abundance at intervals of a few years and some every year. Porous soils with abundant moisture and good drainage, combined with a moderate amount of sunlight, give the best results in germination and early growth.

California red fir is found principally at high elevations in the mountain ranges of southern Oregon and northern and eastern California (fig. 4). In Oregon it generally occurs between 5,000 and 7,000 feet above sea level and in California at somewhat higher elevations. Toward the southern extremity of its range it ascends to over 10,000 feet. Mature trees generally reach a height of 125 to 175 feet and diameter of 30 to 50 inches. Much larger specimens are said to have been found. Trees 20 to 36 inches in diameter are from 225 to 370 years old.

California red fir is a prolific seeder, especially in open stands of moderately old trees. The seeds germinate and grow readily in cool, moist, sandy soil provided there is little or no shade. This inability to endure shade continues throughout life and often results in the trunks of mature trees in dense stands being quite clear of branches which have died from lack of sunlight. California red fir grows both in pure stands, often of considerable size, and in mixture with other species.

FIGURE 3.—Range of Pacific silver fir (*Abies amabilis*).

Noble fir grows principally in western and northern Washington and in western Oregon. (See fig. 5.) Trees of this species sometimes reach a height of 200 feet, diameter of 6 feet, and an age of 400 years or more. Under favorable conditions the trunk is straight and often clear of branches for 100 feet.

Noble fir is the most important of the western true firs as a source of high-grade lumber.[2]

Alpine fir is the smallest of the six commercial western true firs and the least important commercially. It grows from Alaska southward almost to the Mexican border and is found principally on the high slopes and ridges of the Rocky Mountains. (See fig. 6 for distribution in the United States.) Mature alpine fir trees are generally 60 to 90 feet high and 14 to 24 inches in diameter. The trunks are commonly covered with branches from the ground up. Under the most favorable conditions exceptional trees may reach a height of 100 feet and diam-

[2] A separate leaflet in the American Woods series is devoted to noble fir. The suitability of the wood for aircraft construction and the enormous aircraft war program have resulted in heavy demands for high-grade noble fir and increased commercial recognition as a separate species.

eter of 4 feet. Trees from 12 to 20 inches in diameter grown under average conditions are from 140 to 210 years old. Alpine fir bears a moderate amount of seed, and reproduction is usually abundant both in the open and under shade.

FIGURE 4.—Range of California red fir (*Abies magnifica*).

Supply.—The estimated stands of the eight western true firs are given in table 1. The estimates cover material of saw-timber size in the United States. White fir (*A. concolor*) and Pacific silver fir make up about 36 and 33 percent, respectively, of the "white fir" stand. Noble fir, the best of the true firs as a lumber tree, comprises only about 7 percent of the total.

TABLE 1.—*Estimated stands of the western true firs of saw-timber size*

[Billions of board feet—Lumber tally]

Species	Total	Washington	Oregon	California	Nevada	Idaho	Montana	Wyoming	Utah	Colorado	Arizona	New Mexico
Noble fir (*Abies procera*)	8.6	[1] 3.0	[2] 5.6	Negligible	None	None	None	None	None	None	None	None
California red fir [3] (*A. magnifica*)	10.5	None	[2] 2.5	[4] 8.0	Negligible	None	None	None	None	None	None	None
White fir (*A. concolor*)	44.5	Negligible	[5] 5.6	[4] 30.4	Negligible	[6] 1.0	Negligible	Negligible	[6] 3.0	[6] 3.0	[6] 0.5	[6] 1.0
Grand fir (*A. grandis*)	15.9	[1] 1.7	[5] 6.5	[4] 2.3	None	[7] 5.2	[7] 0.2	Negligible	None	None	None	None
Pacific silver fir (*A. amabilis*)	40.3	[1] 36.9	[1] 3.4	None	None	None	None	None	None	None	None	None
Alpine fir (*A. lasiocarpa*)	1.9	[1] 0.6	[1] 0.3	Negligible	None	[6] 0.2	[6] 0.2	Negligible	[6] 0.1	[6] 0.3	[6] 0.1	[6] 0.1
Corkbark fir (*A. arizonica*)	Negligible	None	None	None	None	None	None	None	None	Negligible	Negligible	Negligible
Bristlecone fir (*A. venusta*)	Negligible	None	None	Negligible	None	None	None	None	None	None	None	None
Total	[8] 121.7	[1] 42.2	[1] 23.9	[8] 40.7	Negligible	[9] 6.8	----------	Negligible	----------	[8] 8.1	----------	----------

[1] Based on data furnished by the Pacific Northwest Forest and Range Expt. Sta. ANDREWS, H. J., and COWLIN, R. W. FOREST RESOURCES OF THE DOUGLAS-FIR REGION. U. S. Dept. Agr. Misc. Pub. 389, 169 pp., illus. 1940. Also COWLIN, R. W., and MORAVETS, F. L. FOREST STATISTICS FOR EASTERN OREGON AND EASTERN WASHINGTON. Forest Res. Note 25, 14 pp., illus. 1938. [Processed.] These publications are the result of a survey of the forest resources of Washington and Oregon as part of a Forest Survey of the United States.

[2] The sum of the estimates for noble fir and California red fir in Oregon (8.1 billion bd. ft.) is the forest survey figure for these species combined. The distribution of the 8.1 billion feet between the two species is an estimate.

[3] Includes Shasta red fir (*A. magnifica shastensis*).

[4] Based on U. S. FOREST SERVICE. CALIFORNIA FOREST STATISTICS. Calif. Forest and Range Expt. Sta. Tech. Note 16, 17 pp. 1941. [Processed.]

[5] The sum of the estimates for white fir and grand fir in Oregon (12.1 billion bd. ft.) is the forest survey figure for these species combined. Distribution of the 12.1 billion feet between the 2 species is an estimate.

[6] Estimate.

[7] Based on RAPRAEGER, E. P. POSSIBILITIES OF WOOD-PULP PRODUCTION IN THE NORTHERN ROCKY MOUNTAIN REGION. U. S. Forest Serv., Northern Rocky Mountain Forest and Range Expt. Sta. Paper 4, 43 pp. 1941. [Processed.]

[8] Based on data prepared by the U. S. Forest Service on FOREST LANDS IN THE UNITED STATES for the Joint Committee on Forestry, 77th Cong., 1st sess., Senate Doc. 32, 44 pp. 1941.

[9] Figure obtained by subtracting the sum of the stands of the true firs in Washington and Oregon (Forest Survey figures 42.2+23.9=66.1 billion bd. ft.) from the stand of true firs in the Columbia River Basin (Joint Congressional Committee figure 72.9 billion bd. ft.).

Production of Lumber.—The volume of "white fir"[3] cut for lumber increased irregularly from 52,725,000 board feet in 1905 (when "white fir" was first reported separately from other species) to 349,984,000 board feet in 1926 (fig. 7). After 1926, production decreased to a low of 51,503,000 board feet in 1932—less than in 1905. By 1942 production had risen to 274,295,000 feet and in 1943 reached 403,175,000 board feet, which is the maximum so far attained. The average annual cut of "white fir" for lumber for the 10-year period 1934–43 was 162,227,000 board feet. During this period approximately 50 percent of the lumber cut came from California, 17 percent from Idaho, 15 percent from Oregon, and 13 percent from Washington.

California has always been the leading State in the production of "white fir" lumber. It is estimated that about 90 percent of this lumber cut in California is white fir (*A. concolor*), 9 percent grand fir, and 1 percent California red fir. The lumber from Idaho sold as "white fir" is largely grand fir. "White fir" lumber from Washington and Oregon is a mixture of a number of true firs. Because of the greatly increased demand for noble fir for aircraft construction, it is probable that in 1943 about 75 percent of this mixture was noble fir.

Pulpwood.—"White fir" pulpwood was first listed separately in the Census reports in 1909. In that year 37,176 cords were consumed. Since then consumption has increased markedly but irregularly with a maximum of 213,445 cords in 1940[4] and a minimum of about 31,000 cords in both 1910 and 1919. It is estimated that about 140,000 cords of "white fir" pulpwood were consumed in 1944. The average annual consumption of "white fir" pulpwood for the 10-year period 1931–40 was about 133,000 cords, equivalent to approximately 67,000,000 board feet.[5] A large proportion (probably two-thirds) of the "white fir" used for making paper is pulped by the sulfite process[6] and nearly

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[3] Includes six species of the western true firs grouped together as "white fir" in the statistics of lumber production prepared jointly by the Bureau of the Census and the U. S. Forest Service. It is quite possible that these production figures do not include the entire "white fir" cut, since some "white fir" logged and milled with other woods, such as the pines, was probably reported as such.

[4] The latest year for which statistics on the consumption of "white fir" pulpwood are available.

[5] On the basis of 500 board feet per cord.

[6] Six processes are used commercially in making paper pulp from wood. One is the mechanical or ground-wood process, in which the wood is reduced to pulp on a grindstone. The yield approaches 100 percent of the weight of the wood. Four are chemical processes—the sulfite, sulfate, soda, and neutral sulfite. They depend upon the dissolving action of chemical reagents which remove essentially all of the binding material (lignin) surrounding the cellulose fibers and leave them in a fairly pure state. The removal of the lignin is accomplished by cooking the wood chips with the proper chemical under steam pressure. The yield of pulp is about one-half the weight of the wood. In a sixth process, the semichemical, part of the lignin is removed by chemical means, and the resultant pulp, containing some lignin, is further refined by mechanical means. The yield of semichemical pulp is intermediate between the yields obtained with the mechanical process and the chemical processes.

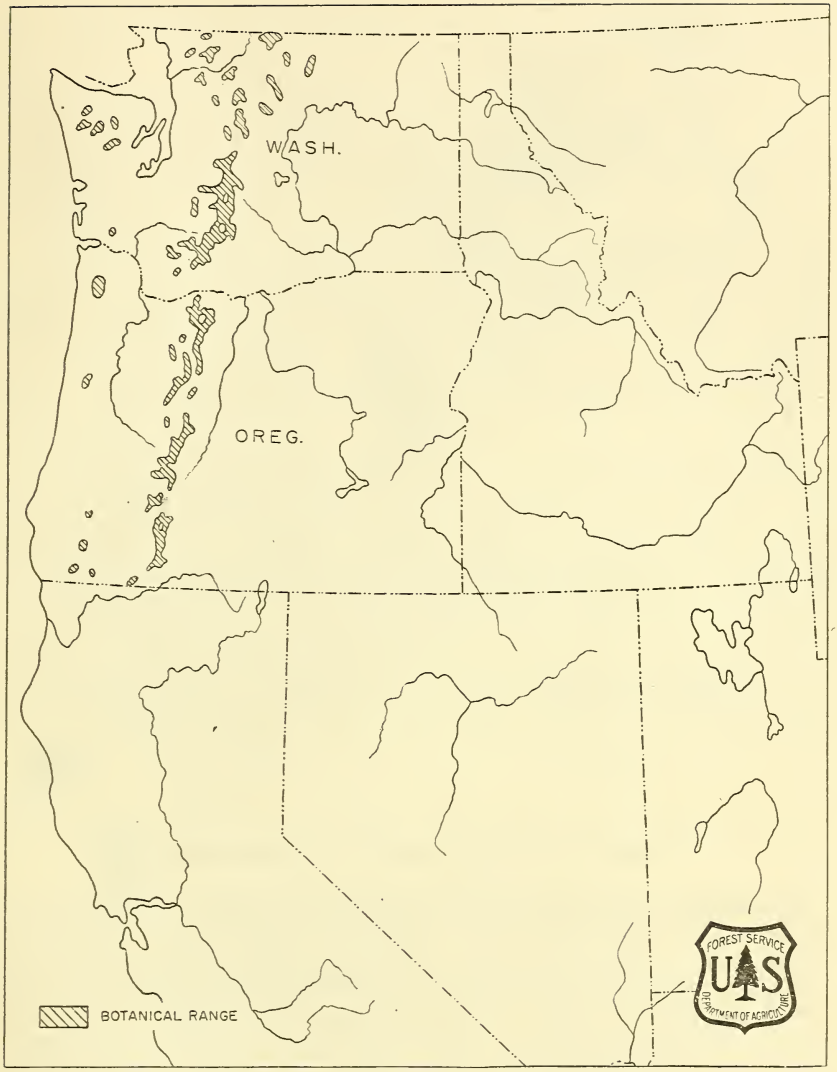

FIGURE 5.—Range of noble fir (*Abies procera*).

all of the remainder by the mechanical process. "White fir" is also pulped by the sulfate process but only in very limited amounts.

In addition to the "white fir" used for lumber and pulpwood, indeterminate amounts go into fuel wood, railroad ties, and local uses. The average annual cut of "white fir" for all purposes in recent years is estimated roughly at 225,000,000 board feet.

FIGURE 6.—Range of alpine fir (*Abies lasiocarpa*).

Properties.—The two woods of which the cut of "white fir" is largely made up—white fir (*A. concolor*) and grand fir (*A. grandis*)—are quite similar in appearance and properties. The annual rings of both are distinct and consist of comparatively wide bands of springwood, flat white in color, and narrow bands of summerwood with a slight reddish-brown tinge. The heartwood and sapwood are generally not distinguishable. When green, the wood of both species has a rather disagreeable odor not present in seasoned material. The two woods are light in weight,[7] have a moderately small shrinkage in drying, and are in general free from pitch. As compared to western (Idaho) white pine, their weight is about the same and shrinkage slightly less.

White fir and grand fir are moderately low in bending strength, moderately soft, moderately low in shock-resisting ability, moderately stiff, and low in nail-holding ability. Grand fir is generally above white fir in shock-resisting ability and stiffness. Of the four other

[7] In a thoroughly air-dry condition (12 percent moisture) "white fir" has an average weight of 26 pounds per cubic foot and grand fir an average weight of 28 pounds per cubic foot.

species of western true fir which may occur in small quantities in "white fir" lumber, alpine fir is decidedly the lowest in weight and strength properties.[8] California red fir is somewhat harder and slightly stronger. When uniform material is desired, neither should be included in "white fir" shipments. White fir and grand fir are more difficult to season than the western pines with which they grow. With care, however, kiln-drying and air-seasoning can be accomplished satisfactorily without undue loss from checking, warping, and loosening of knots.

The decay resistance of both the heartwood and sapwood of white fir and grand fir is low, and both sapwood and heartwood are resistant to the penetration of preservatives. The two species can, however, be treated satisfactorily by methods especially adapted to them. Both can be easily glued. In paint-holding ability they do not rank high, being classed with ponderosa pine, western hemlock, and the spruces in this respect, below the cedars and white pines, and above southern pine and Douglas-fir.

The various species that make up "white fir" are well adapted to the manufacture of pulp and paper. With the standard sulfite process they produce unbleached pulps of excellent color and strength. The fibers are somewhat coarser than spruce fibers, but the pulp is easily bleached and of a quality suitable for newsprint, light-colored wrapping, and book and other high-grade printing papers. A strong unbleached pulp of a dark color suitable for high-grade wrapping papers and fiberboard is produced from "white fir" with the sulfate process. Sulfate pulps from these woods require considerably more bleaching powder to bring them to a light color than do pulps made by the sulfite process. When pulped by the mechanical process, "white fir" produces pulp of excellent color and strength suitable for

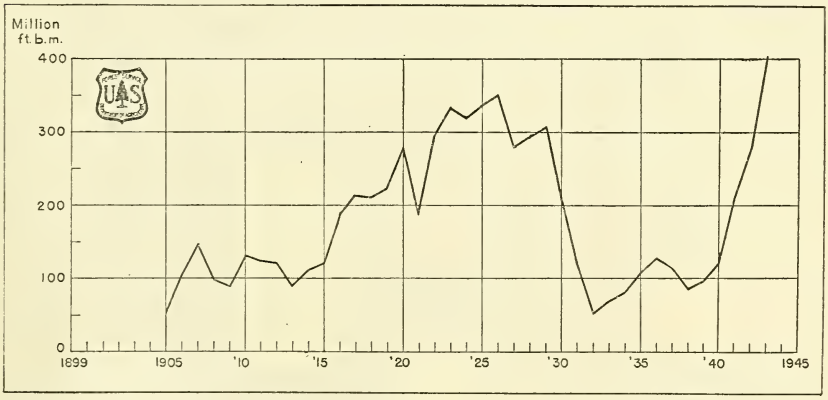

FIGURE 7.—Lumber production of white fir (includes six species of the western true firs), 1905–1943.

all uses requiring ground wood. About 20 percent more power is required to grind these firs than to grind white spruce—a wood long used for mechanical and other pulps.

[8] The weights of these firs in a thoroughly air-dry condition (12 percent moisture) are as follows: Pacific silver fir—27 pounds per cubic foot, California red fir—27 pounds per cubic foot, noble fir—26 pounds per cubic foot, and alpine fir—23 pounds per cubic foot.

Principal uses.—"White fir" is used principally for lumber and pulpwood. The lumber goes largely into building construction; boxes and crates; planing mill products; and sash, doors, frames, and general millwork. Probably at least 75 percent of all "white fir" lumber is used for small house construction in the form of framing, subflooring, and sheathing, and about 15 percent goes into boxes and crates. The white color, light weight, freedom from stain and pitch, and lack of odor when dry make the wood well suited for such containers. "White fir" pulpwood is used chiefly in the manufacture of various grades of printing paper and high-grade wrapping paper.

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